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Research on the Evaluation of higher Education Health system based on Principal Component Analysis

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Abstract: The higher education system is the most important component of civic education in addition to primary and junior secondary education, and is therefore valuable both as an industry itself and as a source of national economic training and educated citizens. It is very important for a country to have a healthy and sustainable higher education system. First of all, this paper sets up six indicators to judge the health status of the higher education system: the number of higher education institutions, government education expenditure, the number of students receiving higher education, the number of teachers receiving higher education, student satisfaction and international exchanges. Then establish the principal component analysis model, through the principal component analysis to judge that among the six influencing factors, the number of colleges and universities, government education funds, the number of students receiving higher education and the number of teachers are the main influencing factors. Taking the above main factors as eigenvalues, the same number of countries are selected from the top, list and bottom of the list according to the list of the best countries in education in the world, and their relevant data are collected. The fuzzy comprehensive evaluation model is used for modeling and evaluation, and the analysis results of many countries are obtained.

1. Introduction

The evaluation of higher education plays a positive role in standardizing the teaching quality standard of higher education and promoting the quality of personnel training. Supervision and evaluation system is a new form and concept of higher education evaluation based on the summary and reflection of the existing evaluation theory and practice, which conforms to the development trend of contemporary educational evaluation. This is of great significance for enriching the theoretical system of educational evaluation and perfecting the practical form of educational evaluation [1-4].

2. Construction of principal component analysis model

2.1 Model preprocessing

Firstly, the paper centralize the M n-dimensional data $\left(x^{(1)}, x^{(2)}, \ldots, x^{(m)}\right)$ we collected to make

$\sum_{j=1}^{m} x^{(i)} = 0$. After the projection transformation, we get a new coordinate system $\{w_1, w_1, \ldots, w_n\}$, where w is an orthonormal basis and $\| \mathbf{w} \|_2 = 1, w_i^T w_j = 0$.

In order to make all the samples close enough to the hyperplane, minimize the processing- $\sum_{i=1}^{m} \| x^{-} - x^{(i)} \|$.

Where, $|\sum_{i=1}^{m} x^{(i)} x^{(i)T}$ is the covariance matrix of the data set, and each vector of W is an orthonormal basis [5]. The above equation can be equivalent to:

$$J(W) = -tr\left(W^T X X^T W\right) + \lambda\left(W^T W - I\right) \tag{1}$$

Therefore, it is necessary to find the eigenvector corresponding to the maximum N eigenvalues. The matrix W of N prime Eigenvectors is the matrix we need. Then the main eigenvalues are obtained by model calculation.

2.2 Process and data processing

The process and data preprocessing process are as follows:

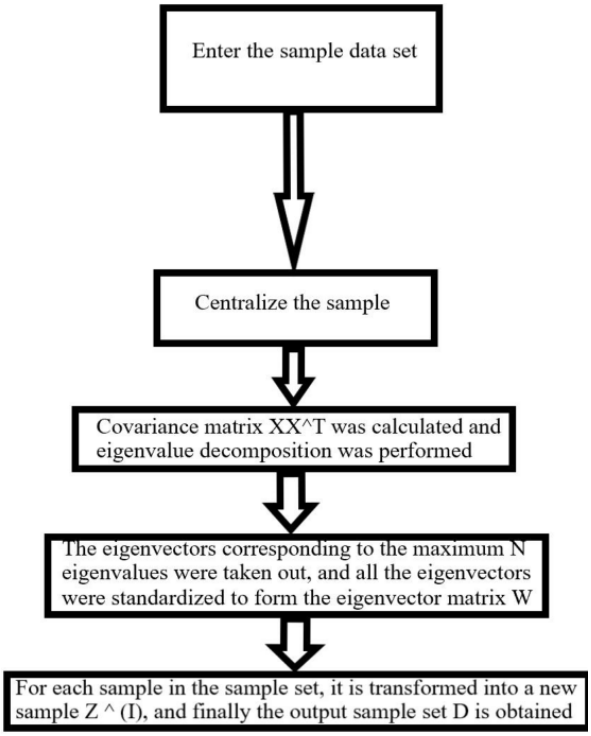

Figure 1: Establishment of data processing process

Result 1:

{'Eigenvalue'}	{'D-value' }	{'Contribution rate'}	{'accumulative contributi…'}
{[1.1589e+04]}	{[8.0607e+03]}	{[64.6807]}	{[64.6807]}
{[3.5279e+03]}	{[1.0448e+03]}	{[19.6905]}	{[84.3712]}
{[2.4830e+03]}	{[2.1858e+03]}	{[13.8589]}	{[98.2301]}
{[297.2431]}	{[277.8145]}	{[1.6590]}	{[99.8891]}
{[19.4286]}	{[18.9941]}	{[0.1084]}	{[99.9976]}
{[0.4345]}	{0×0 double }	{[0.0024]}	{[100]}

Result 2:

{'Normalized variable'}	{'Prin1'}	{'Prin2'}	{'Prin3'}
{'x1:Number of top univer…'}	{[0.4423]}	{[0.5541]}	{[0.7045]}
{'x2:Government expenditu…'}	{[0.8519]}	{[-0.5052]}	{[-0.1378]}
{'x3:Number of students i…'}	{[0.2790]}	{[0.6608]}	{[-0.6962]}
{'x4:Student satisfaction'}	{[1.4642e-04]}	{[8.9561e-05]}	{[3.8962e-05]}
{'x5:Number of professors'}	{[0.0290]}	{[0.0277]}	{[0.0040]}
{'x6:International Traffic'}	{[0.0070]}	{[0.0164]}	{[-0.0034]}

Figure 2: Processing result

Based on the above results, the paper selected the main influencing factors after comparison:
'x1: Number of First-class Universities '; 'x2: Government expenditure on education ';
'x3: Number of students receiving higher education '; 'x4: Student Satisfaction'

3. Fuzzy clustering processing of Index system

Determine the indicators: According to the principal component analysis model, we get the main influencing factors as:
'x1: Number of First-class Universities '; 'x2: Government expenditure on education ';
'x3: Number of students receiving higher education '; 'x4: Student Satisfaction'.
The membership function is determined according to the principle:
'x1: Number of First-class Universities ';

$$y=\begin{cases}\dfrac{10x}{x_{\max}} & if\ (x<0.1x_{\max})\\ 0 & f\ (x<0)\\ 1 & else\end{cases} \tag{2}$$

'x2: Government expenditure on education ';

$$\begin{cases}0 & if\ (x<0.5\bar{x})\\ \dfrac{x-0.5\bar{x}}{2.5\bar{x}} & else\\ 1 & if\ (x>4\bar{x})\end{cases} \tag{3}$$

'x3: Number of students receiving higher education ';

$$y=\frac{x}{x_{\max}} \tag{4}$$

'x4: Student Satisfaction';

$$y=x^2 \tag{5}$$

In the short term, the data of the current year is used to calculate the membership matrix R, while in the long term, the average value of each statistic is used according to the growth trend of the recent

10 years, and then the membership function is substituted to calculate the membership.

Country	GROWTH	AVG	CSP	FF
United States	0.205491	1.000000	1.000000	1.000000
China	0.197583	0.681648	0.165207	0.103041
Indonesia	0.000000	0.442457	0.066413	0.004679
France	1.000000	1.000000	0.351892	0.543759
India	0.222710	0.192865	0.426896	0.343396
Pakistan	0.065537	0.142689	0.023294	0.001936
Spain	0.000000	1.000000	0.258549	0.384276
Tanzania	0.000000	0.098813	0.089542	0.000000
Germany	0.113426	1.000000	0.262019	0.511654
Philippines	0.025128	0.302386	0.043119	0.003493
Thailand	0.067168	0.696973	0.096811	0.041943
Russian Federation	1.000000	1.000000	0.150339	0.394887
Bangladesh	0.187528	0.109653	0.049067	0.000660

Figure 3: Programming matrix value

4. Index decision matrix

According to the importance estimation, we get the following judgment matrix:
0.2 0.5 0.2 0.1;
0.7 0.2 0.1 0;
0 0.4 0.5 0.1;
0.2 0.3 0.5 0;
The corresponding weight vector
A=[0.11609794 0.57847007 0.23367261 0.07175938].
Test evaluation matrix:
cr is: (0.0877731194814+0j)
cr < 0.1, It shows that the judgment matrix is reliable.

5. Case analysis and verification

Matlab programming solution is:
(a) 0.200 0.3000 0.4000 0.1000
(b) 0.3500 0.4000 0.2000 0.1000

Referring to the judgment matrix, we can know that: Higher education in Tanzania is "not excellent". China's higher education 'relatively excellent'.
Evaluate and instantiate different countries:

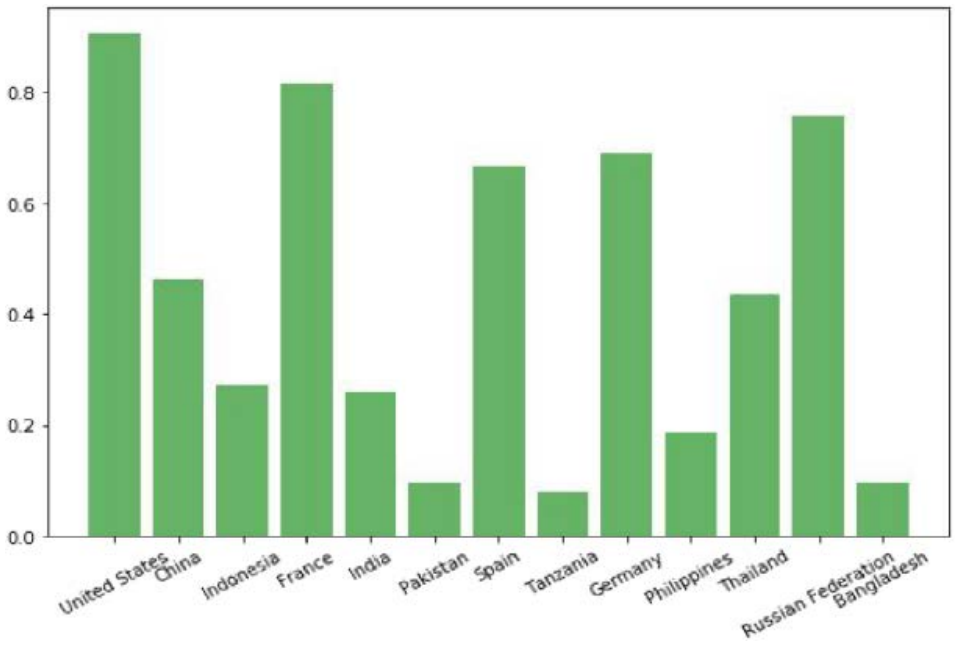

Figure 4: Case evaluation results

6. Conclusion

It is very important for a country to have a healthy and sustainable higher education system. The development level of higher education is an important symbol to measure a country's comprehensive national strength and development potential. In this paper, six indicators are set to judge the health status of higher education and take the above main factors as eigenvalues. According to the list of the best countries in global education, the same number of countries are selected and the relevant data are collected. The fuzzy comprehensive evaluation model is used to model and evaluate the analysis results of many countries.

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